(12) UK Patent Application (19) GB (11) 2 327 773 (13) A

(43) Date of A Publication 03.02.1999

(21) Application No 9815628.4

(22) Date of Filing 20.07.1998

(30) Priority Data
(31) 97035590 (32) 28.07.1997 (33) KR

(71) Applicant(s)
Samsung Electronics Co Limited
(Incorporated in the Republic of Korea)
416 Maetan-dong, Paldal-gu, Suwon-city,
Kyungki-do, Republic of Korea

(72) Inventor(s)
Tae-Hyung Rhee

(74) Agent and/or Address for Service
Eric Potter Clarkson
Park View House, 58 The Ropewalk, NOTTINGHAM,
NG1 5DD, United Kingdom

(51) INT CL$^6$
G02B 6/10

(52) UK CL (Edition Q )
G2J JGAT

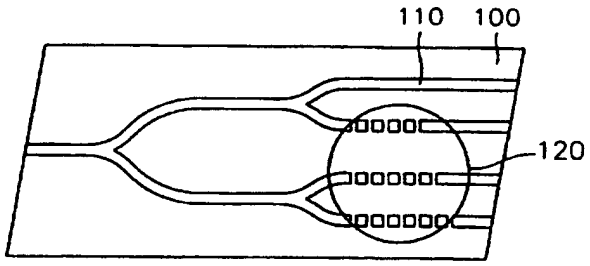
(56) Documents Cited
Journal of Lightwave Technology Vol 11 No 11 Nov 1993 pages 1831-1838

(58) Field of Search
UK CL (Edition P ) G2J JGAT
INT CL$^6$ G02B
Online: WPI, JAPIO

(54) Abstract Title
**Planar optical segmented waveguide for attenuation**

(57) A planar waveguide device having a segment waveguide 120 to obtain equal splitting and equal output, comprises a segment waveguide having optical waveguide segments for generating a small optical signal intensity attenuation within a waveguide, to control waveguide output signal intensity and equalize the intensity of optical signals between waveguide output ports of the waveguide device fabricated on a single planar substrate. The segment waveguide and the waveguide 110 may be simultaneously fabricated. Planar substrate 110 is shown.

FIG. 2




GB 2 327 773 A

FIG. 1

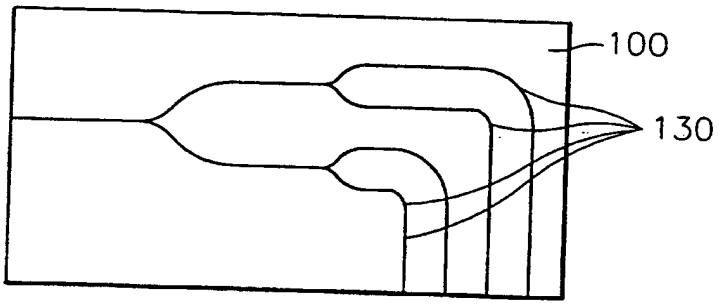



FIG. 2

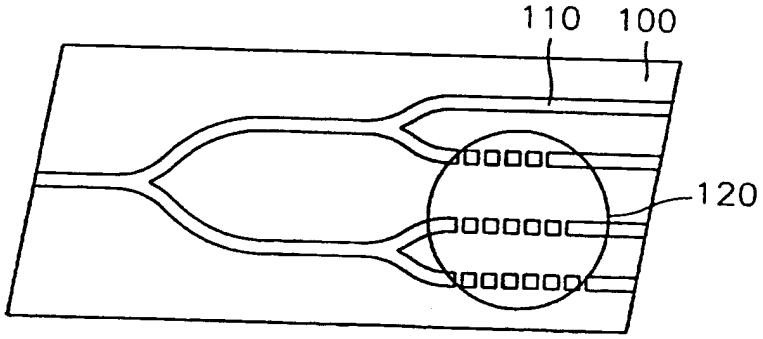


FIG. 3

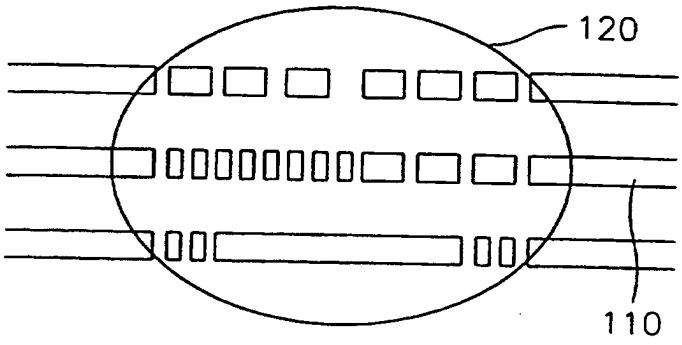
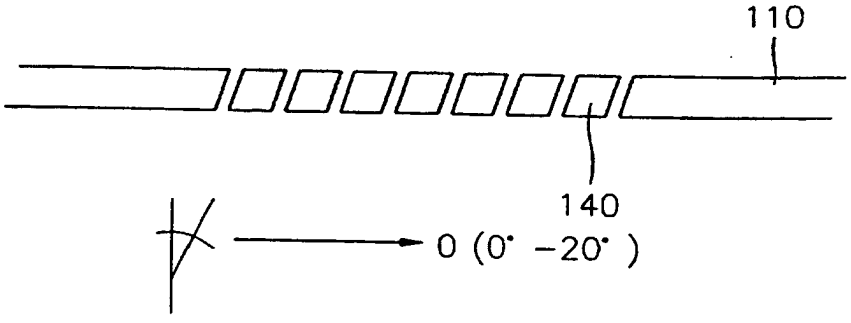



FIG. 4



# PLANAR WAVEGUIDE DEVICE HAVING SEGMENT WAVEGUIDES

## BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a planar waveguide device, and more particularly, to an optical planar waveguide having an equal splitting ratio or an equal output intensity between waveguide outputs on account of segment waveguides.

2. Description of the Related Art

For the purpose of optical signal processing such as splitting, modulation, switching, multiplexing or equalization of an optical signal, much research has been made into optical device integration technology for fabricating an optical waveguide on a planar substrate using planar waveguide technology. Roughly three technologies of waveguide design, fabrication, and packaging are required to manufacture an optical waveguide for use in an optical communications system.

For some purposes, the optical waveguide device must make a waveguide asymmetrical or make the path distance different. When such a waveguide is fabricated or packaged, signal intensity attenuation or other losses such as signal attenuation necessarily occur. In this case, particularly, in the case of a waveguide using a Y-splitting point, the property of accurately controlling a splitting ratio is important. Also, in the case of a waveguide which uses the Y-splitting point and has an asymmetrical structure, the splitting ratio must be controlled artificially. In the prior art, there is no special technique capable of solving the above problems and suitable for mass production, so that the control of the splitting ratio was individually, manually accomplished. FIG. 1 shows an example of an asymmetrical optical waveguide, in which reference numeral 100 is a planar substrate and reference numeral 130 is an asymmetrical waveguide.

In the general fabrication of an asymmetrical optical waveguide device, each waveguide necessarily outputs a different optical signal due to a difference in the distance each optical signal travels or a difference in signal attenuation. Also, the optical waveguide device can have an unequal splitting ratio or a difference in

For this, the segment waveguide 120 has a structure in which signal attenuation is generated between a waveguide and a waveguide segment which is nearest to the waveguide or between adjacent waveguide segments. Also, the segment waveguide 120 has a structure in which the tilt or off-set of an optical axis exists between a waveguide and a waveguide segment which is nearest to the waveguide or between adjacent waveguide segments.

A material such as cladding or a material having a smaller refractive index than a segment is used between segments or between a waveguide and a segment. In the waveguide device organized as described above, the signal attenuation is increased using the structure and arrangement of segments in the sequence of a waveguide having a highest output intensity, to control the output intensities of all waveguides. Also, the angle of the segment waveguide is controlled when necessary, to reduce the reflection loss generated by the segment waveguide. FIG. 4 shows an example of reducing the reflection loss in a waveguide by arbitrary processing on the angle. Here, reference numeral 140 denotes a segment having a predetermined angle $\theta$ ($0 \leq \theta \leq 20°$).

The waveguide and the segment waveguide are fabricated simultaneously by the same process.

According to the present invention, only a simple structure capable of attenuating an optical signal is added upon fabricating a waveguide, and the added structure and the waveguide are simultaneously fabricated, so that there is no need to have an additional process or provide additional accuracy to control the output intensity difference generated at an output waveguide port of an optical waveguide device. Also, additional processes or special efforts are not required for packaging and installation, and factors of cost increase upon fabricating a device performing an equivalent function can be eliminated.

FIG. 2 shows the structure of an asymmetrical optical waveguide device including waveguides having an equal splitting ratio, according to a preferred embodiment of the present invention;

FIG. 3 shows the structure of a segment waveguide according to a preferred embodiment of the present invention; and

FIG. 4 shows the structure of a waveguide including a segment waveguide angled to reduce reflection loss.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

In the present invention, a simple structure capable of attenuating an optical signal in fabrication of a waveguide is included in the waveguide. Also, the present invention equalizes the entire output intensity of every output waveguide while maintaining the same process and accuracy as in the prior art upon fabrication of a waveguide. Referring to FIG. 2, reference numeral 100 is a planar substrate, reference numeral 110 is a waveguide, and reference numeral 120 is a segment waveguide.

The segment waveguide 120 obtains an equal splitting ratio of waveguides or a uniform output intensity between waveguides by compensating for an unequal splitting ratio of a waveguide optical signal or a difference in output intensity between waveguides. The segment waveguide 120 is comprised of optical waveguide segments for generating small optical signal intensity attenuation within the waveguide. The optical waveguide segments can control output intensities at waveguide output ports of a waveguide device fabricated on a single planar substrate and equalize the intensity of optical signal between waveguide outputs.

In order to control the output intensity of each waveguide to within a predetermined range upon designing an asymmetrical waveguide, based on the output intensity of the lowest output waveguide, all or part of other waveguides are fabricated using the segment waveguide. FIG. 3 shows various structures of the segment waveguide 120. The attenuation degree of the output of a waveguide is controlled by the number of segments included in each waveguide, the interval between the segments in a waveguide, and the degree of distortion between the segments.

8. A planar waveguide device substantially as described with reference to the accompanying drawings.

What is claimed is:

1. A planar waveguide device which can control a splitting ratio of a waveguide or/and waveguide output intensities, comprising:

a segment waveguide having optical waveguide segments for generating a small optical signal intensity attenuation within a waveguide, to control waveguide output signal intensities and equalize the intensity of optical signals between waveguide output ports of the waveguide device fabricated on a single planar substrate.

2. The planar waveguide device as claimed in claim 1, wherein the segment waveguide has a structure in which signal attenuation is generated between a waveguide and a waveguide segment that is nearest to the waveguide.

3. The planar waveguide device as claimed in claim 1, wherein the segment waveguide has a structure in which signal attenuation is generated between adjacent waveguide segments.

4. The planar waveguide device as claimed in claim 1, wherein the segment waveguide has a tilt or off-set in an optical axis between the waveguide and a waveguide segment that is nearest to the waveguide or between adjacent waveguide segments.

5. The planar waveguide device as claimed in claim 1, wherein the waveguide and the segment waveguide are simultaneously fabricated using an identical process.

6. The planar waveguide device as claimed in claim 1, wherein both ends or one end of the waveguide or at least one segment waveguide are slanted at a predetermined angle $\theta$ ($0 \leq \theta \leq 20°$).

7. The planar waveguide device as claimed in claim 1, wherein the number of segments of the segment waveguide is adjusted to control the signal intensity attenuation of an optical signal.

The Patent Office

| | | | |
|---|---|---|---|
| **Application No:** | GB 9815628.4 | **Examiner:** | Chris Ross |
| **Claims searched:** | 1-8 | **Date of search:** | 5 October 1998 |

## Patents Act 1977
## Amended Search Report under Section 17

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): G2J(JGAT)

Int Cl (Ed.6): G02B

Other: Online: WPI, JAPIO

**Documents considered to be relevant:**

| Category | Identity of document and relevant passage | Relevant to claims |
|---|---|---|
| A | Journal of Lightwave Technology Vol 11 No 11 Nov 1993 pp 1831-1838 Fig 10 | |

| | | | |
|---|---|---|---|
| X | Document indicating lack of novelty or inventive step | A | Document indicating technological background and/or state of the art. |
| Y | Document indicating lack of inventive step if combined with one or more other documents of same category. | P | Document published on or after the declared priority date but before the filing date of this invention. |
| & | Member of the same patent family | E | Patent document published on or after, but with priority date earlier than, the filing date of this application. |